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Seasonal variation and locality of enhanced gamma dose rates during precipitation in Japan

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Abstract

Atmospheric gamma (γ) dose rates, monitored with NaI (Tl) scintillation detector at six monitoring sites in Japan from 2000 to 2004, were analyzed. The variations of enhanced (Δ) γ dose rates during precipitation were discussed in relation to air mass classification by backward trajectory analysis and synoptic weather feature.

The Δ γ dose rates at Minamihoroni (43°N, 140.6°E), Kariwa (37.4°N, 138.6°E), and Wajima (37.4°N, 136.9°E) showed significant seasonal variation. The Δ γ dose rates in autumn–winter were high with large variation (~57, 71, and 102 nGy/h at Minamihoroni, Kariwa, and Wajima, respectively), whereas those in summer were low with small variation (~30, 32, and 41 nGy/h). The seasonal variation of the Δ γ dose rates suggests that ^{222}Rn and its progenies transported from the Asian continent are abundant in autumn–winter, whereas scarce in summer over Japan. The air masses poor in ^{222}Rn transported from the Pacific Ocean, in another sense, attribute to low Δ γ dose rates in summer.

At Asahikawa (43.8°N, 142.4°E), there was a small seasonal variation with high Δ γ dose rates (~ 35 nGy/h) in autumn–winter and low (~ 13 nGy/h) in summer, except 2000. By comparison, there was little seasonal variation of Δ γ dose rates (~ 44 and 49 nGy/h) at Ohno (37.4°N, 141.0°E) and Tokai-mura Oshinobe (36.5°N, 140.6°E).

Temporal variations of Δ γ dose rates are strongly influenced by the variation of ^{222}Rn progenies concentrations transported from the Asian continent, air mass origin, and precipitation pattern over the Japanese islands. The present data analysis indicates that wet deposition of ^{222}Rn progenies derived from the Asian continent is significantly large in autumn–winter at the coast of the Japan Sea.

Extraordinary high Δ γ dose rates events (> 50 nGy/h) were measured at Wajima during a passage of a cyclone associated with a cold front. A large wet deposition of ^{222}Rn progenies from the Asian continent (remote component) and convection associated with the cyclone (or cold front) around the Japanese islands (accumulating local component) attributed to the extraordinary high Δ γ dose rates. Simultaneous occurrence of favorable conditions seems the cause of such extraordinary high Δ γ dose rates events; enhanced ^{222}Rn and its progeny concentrations not only in the boundary layer but also in the free troposphere due to the active transport from the Asian continent and subsequent convection over the Japanese islands, and resulted precipitation over the site.